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ABSTRACT

The objective of the project was to generate historical estimates and projections of employment demand by industry and occupation (industry-occupation matrices) for the state of Pennsylvania and 12 metropolitan labor market areas in the state. The methodology is discussed in two sections. The first section is concerned with the methodology used in arriving at historical estimates and projections of the industry-occupation matrices. The second section presents procedures used in computing annual change factors for each occupation in each area, for the period 1970-80, given the benchmark years data for 1970, 1975, and 1980. A list of 88 industries is appended. (Author/EC)

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Projections of Employment Demand by Industry and Occupation for Labor Market Areas in Pennsylvania

(Project No. 14-2119)
School Unit 3-00-00-610-0

for

Pennsylvania Department of Education
Bureau of Vocational, Technical and Continuing Education

by

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NATIONAL INSTITUTE OF EDUCATION

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Objective

Traditionally, more emphasis has been put on an industrial breakdown of employment than on an occupational breakdown. However, production in any industry is achieved by a combination of capital and labor. And the latter factor of production in each industry consists of workers with different skills. This skill mix (or occupation mix) of each industry changes over time. Therefore, reasonably reliable estimates of occupation mix for each industry constitute an important input data for intelligent manpower planning and programming.

The objective of the present project is to generate historical estimates and projections of employment demand by industry and occupation (industry-occupation matrices) for the State of Pennsylvania and 12 metropolitan labor market areas in the state.

Specification of Final Output

The final output data produced and delivered are as follows:

[A] Employment Demand Estimates and Projections by Industry and Occupation (Industry-Occupation Matrix Form) as specified below.

(1) Areas

1. State of Pennsylvania
2. Allentown-Bethlehem-Easton SMSA Labor Market Area
3. Altonna SMSA Labor Market Area
4. Erie SMSA Labor Market Area
5. Harrisburg SMSA Labor Market Area
6. Johnstown SMSA Labor Market Area
7. Lancaster SMSA Labor Market Area
8. Philadelphia SMSA Labor Market Area
9. Pittsburgh SMSA Labor Market Area
10. Reading SMSA Labor Market Area
11. Scranton SMSA Labor Market Area
12. Wilke-Barre-Hazelton SMSA Labor Market Area
13. York SMSA Labor Market Area
14. Balance of the State Area.

(2) Years

1960 and 1970, historical

1975, 1980, 1985 and 1990, projected

(3) Industries (88 industries) as listed in Appendix I.

(4) Occupations (469 occupations) as listed in Appendix II.

[B] Annual Change Factors by Occupation, Annual 1970-80.

Areas and occupations are the same as those listed in the preceding section.

Methodology

This section is divided into two major subsections. The first is concerned with the methodology used in arriving at historical estimates and projections of the industry-occupation matrices. The second presents procedures used in computing annual change factors for each occupation in each area, for the period 1970-80 given the benchmark years data for 1970, 1975 and 1980.

I. Industry-Occupation Matrices

[A] Estimates of Industry-Occupation Matrices for 1960.

For 1960 no detailed industry-occupation matrix even for the state is available. Fortunately, unpublished 1960 census detailed occupation by industry data for the Northeast Region was obtained from the U.S. Bureau of the Census (296 occupations and 180 industries).

The step by step procedures used in deriving the 1960 occupation-industry matrices for the areas are as follows:

(1) The 1960 census provides occupation-industry matrices (small scale, i.e., 45 industries by 64 occupations) for state and large metropolitan areas. Therefore, the first step involves expanding the small matrices into the larger matrices (296 occupations and 88 industries).

As a preliminary step, the 180 industries provided in the Northeast Region matrix were aggregated into 88 industries, since the final output requires only the 88 industry groups.

The matrix expansion was accomplished by utilizing the pattern of the Northeast Region matrix on the smaller census matrices. This step results in first approximations of the expanded matrices for the areas concerned.

(2) The 1960 Census also provides detailed occupation totals (not an occupation-industry matrix) for each area. Therefore, the initial approximations of the occupation-industry matrices obtained by Step (1) above were adjusted to conform with the occupation vectors as reported in the Census (Table 121). This process resulted in staffing patterns for the 88 industries to be used in the following step.

(3) Since the industry employment estimates for 1960 are different, both conceptually and statistically, from the industry employment reported in the Census, it was necessary to adjust the matrices obtained in Step (2) above. This adjustment was accomplished by applying the staffing patterns obtained by Step (2) above to the industry employment estimates (total jobs as adjusted to mid year) on an industry by industry basis.

(4) The balance of state area occupation-industry matrix was obtained as the difference between the state total and summation of the metropolitan labor market areas.

(5) Reclassification of the 1960 Census occupation classifications to the 1970 Census occupations (from 296 occupations to 469 occupations).

Then the 14 industry-occupation matrices obtained above were adjusted to conform to the 469 occupation classifications.

[B] Estimates of Industry-Occupation Matrices for 1970.

For 1970 a detailed industry-occupation matrix for Pennsylvania State was available from the U.S. Bureau of Labor Statistics.

The procedures used in deriving State and substate area industry-occupation matrices for 1970 can be described as follows:

(1) The above-mentioned state industry-occupation matrix contains 237 industries. So first, the matrix was converted into a matrix of 88 industries by 469 occupations.

(2) The 1970 Census published matrices of 50 industries by 82 occupations for the state and large metropolitan areas (Table 180). Therefore, the next step involves conversion of those small scale industry-occupation matrices into the large matrices, matrices of 88 industries by 469 occupations.

The expansion of the small matrices for the metropolitan areas was done by:

First, the state pattern of detailed industry-occupation matrix was used for generating initial values for the detailed industry-occupation matrices of the metropolitan areas.

Secondly, the initial values of the large matrices obtained above were adjusted to conform to the published small scale matrices for the metropolitan areas.

Thirdly, the 1970 Census provides detailed occupation vectors for the state and metropolitan areas. Therefore, the expanded initial industry-

occupation matrices for the metropolitan areas were adjusted to conform to the published detailed occupation vectors (469 occupations).

Finally, since the industry employment vector (88 industries) and occupation employment vectors (469 occupations) are available as columns totals and rows totals for the expanded initial matrix for each area, a balancing operation was implemented on the initial matrix.

(3) The detailed industry-occupation matrix for the balance of the state was obtained as the difference between the state matrix and summation of all metropolitan areas matrices.

[C] Projections of Industry-Occupation Matrices for 1980.

Since the period for which the historical data were established in the foregoing sections represents a decade, the 1980 projections should be considered the most critical benchmark data from the viewpoint of our projection process. This is the reason why the 1980 projections have been made first in order to establish the most reasonable trends.

(1) For each industry, the staffing patterns in terms of percentage shares of each occupation for 1960 and 1970 were computed.

(2) Compute difference between the 1970 percentage share and 1960 percentage share: D = 1970 Share - 1960 Share.

(3) Compute initial estimate of percentage share for 1980 by adding D obtained above to the 1970 share: 1980 Percentage Share = 1970 Percentage Share

When any resultant 1980 percentage share became negative, that share was made zero.

The procedures used above in arriving at the preliminary staffing pattern of each industry, which utilizes percentage differences rather than simple change factor, implicitly incorporated a built-in process of oppressing extreme changes in occupation mix during the historical period.

(4) Adjustments were made on the initial staffing patterns as obtained by the mechanical fashion above; some extreme values had to be adjusted externally.

(5) Force the initial staffing pattern (in terms of occupation) to add up to 100 percent for each industry.

(6) Finally, apply the staffing pattern to the industry employment projection, on an industry by industry basis, which yields industry-occupation matrix for 1980.

[D] Projections of Industry-Occupation Matrices for 1990.

Procedures similar to those used in arriving at 1980 industry-occupation matrices on the basis of the 1960 and 1970 matrices, were used in deriving the 1990 matrices. This time, of course, 1970 and 1980 matrices were used for projecting to 1990.

[E] Projections of Industry-Occupation Matrices for 1975 and 1985.

The 1975 industry-occupation matrices were obtained by interpolating the staffing patterns between 1970 and 1980 on an industry by industry basis.

The 1985 matrices were derived by interpolating the staffing patterns between 1980 and 1990.

[F] Finally, there are two alternative approaches to getting the state matrices for the projection years: the first, the independently projected state matrices; and the second, the summation of all substate areas to arrive at the state totals. The first approach implies that the independently projected substate areas matrices should be adjusted to add up to the independently projected state matrices for respective projection years.

The summations of all the substate areas projections were compared with the independently projected state totals. We found the two sets were close to each other. Therefore, we took the summations over all the substate areas as the state projections for respective projection years.

II. Annual Change Factors

In order to provide guidelines for annual programming, annual change factors, annually 1970-1980, for each occupation have been computed by the following procedures:

For each occupation, 1970, 1975, and 1980 benchmark data are available.

The average annual rate of increase, r, for the 1970-75 period is computed by solving for r from

(1) $B = A(1+r)^5$

where A stands for employment of 1970, and B for 1975.

(2) $r = -1.0 + (B/A)^{1/5}$

Average annual rate of increase, R, for the 1975-80 period is computed by solving for R from

(3) $D = C(1+R)^5$

where C stands for employment of 1975, and D for 1980.

(4) $R = -1.0 + (D/C)^{1/5}$

The average annual rates of increase r and R as derived by (2) and (4) above represent the averages of the whole 5 years of periods 1970-75 and 1975-80. Therefore, if we used the r and R values for computing annual increase, it is possible to produce a "kink" between years before and after 1975. In order to avoid this kind of unrealistic results, annual change factors must be smoothed along the whole ten year period.

Actually, the values r and R represent the rates for the mid points of the respective periods; i.e., r for 1972-73 and R for 1977-78. Therefore,

the initial annual adjustment factor for the smoothing purpose is obtained by

$$(5) \quad a = (R-r)/5$$

Therefore, preliminary adjusted annual rates of change for the five periods, $\bar{r}_i$, i.e., 1970-71, 1971-72, 1972-73, 1973-74, and 1974-75 are computed by

$$(6) \quad \bar{r}_i = r + a \cdot k$$

where i stands for annual period; i = 1 stands for 1970-71.

And K = i-3.

By the same reason, preliminary adjusted annual rates of change for the five periods $\bar{R}_i$, i.e., 1975-76, 1976-77, 1977-78, 1978-79, and 1979-80 are computed by

$$(7) \quad \bar{R}_i = R + a \cdot m$$

where i stands for annual period; i = 1 for 1975-76. And m = i + 2.

Then we apply the $\bar{r}_i$ and $\bar{R}_i$ to compute hypothetical employment $\bar{B}$ and $\bar{D}$ for years 1975 and 1980, respectively by

$$(8) \quad \bar{B} = A\ (1+\bar{r}_1)\ (1+\bar{r}_2)\ (1+\bar{r}_3)\ (1+\bar{r}_4)\ (1+\bar{r}_5)$$

$$(9) \quad \bar{D} = C\ (1+\bar{R}_1)\ (1+\bar{R}_2)\ (1+\bar{R}_3)\ (1+\bar{R}_4)\ (1+\bar{R}_5)$$

The resultant $\bar{B}$ and $\bar{D}$ may not be equal to B and D, respectively. So we have to compute adjustment factors for the two respective periods by

$$(10) \quad RP = B/\bar{B}$$

$$(11) \quad RD = D/\bar{D}$$

RB and RD are attributable to discrepancies accumulated during the respective five year periods. So annual adjustment factors must be computed by

$$(12)\quad 1 + \delta = RB^{1/5}$$

$$(13)\quad 1 + \omega = RD^{1/5}$$

Consequently, annual change factor for each annual period is computed by

$$(14)\quad RRR_i = [(1+\bar{r}_i)\ (1+\bar{r}_2)\ --\ (1+\bar{r}_i)]\ (1+\delta)^i \quad \text{for 1970-75 period.}$$

$$(15)\quad RRRR_i = [(1+\bar{R}_1)\ (1+\bar{R}_2)\ --\ (1+\bar{R}_i)]\ (1+\omega)^i$$

for 1975-80 period.

The RRR_i and $RRRR_i$ are readily applicable to the initial (benchmark year's) employment for the respective period to yield annual estimates.

APPENDIX I

INDUSTRIES

IND SEQ	SIC CODE	INDUSTRY NAME
01		Total
02		Agriculture, Forestry + Fisheries
07		Mining
08	10	Metal Mining
09	11	Anthracite Mining
10	12	Bituminous Coal + Lignite
11	13	Crude Petrol. + Natural Gas
12	14	Mining of Nometallic Min.
13		Contract Construction
14	15	General Building Construct.
15	16	Other Construction - Not Bld.
16	17	Special Trade Contractors
17		Manufacturing
18		Durables
20	24	Lumber + Wood Prod. - Not Furn.
21	25	Furniture and Fixtures
22	32	Stone, Clay, Glass + Concrete
23	33	Primary Metal Industries
24	34	Fabricated Metal Products
25	35	Machinery Except Electrical
26	36	Elec. Machin. Equip. + Supply
27	37	Transportation Equipment
28	38	Science + Control. Instrum.
29	39	Miscellaneous
30		Nondurables
31	20	Food and Kindred Products
32	21	Tobacco Manufactures
33	22	Textile Mill Products
34	23	Apparel + Fin. Fabric Prod.
35	26	Paper and Allied Products
36	27	Print., Publish., + Allied Ind.
37	28	Chemicals + Allied Products
38	29	Petrol. Refin. + Related Ind.
39	30	Rubber + Misc. Plastic Prod.
40	31	Leather + Leather Products
41		Transp., Commun., + Pub. Utilities
42	40	Railroad Transportation
43	41	Local + Suburban Transit
44	42	Motor Freight - Warehousing
45	44	Water Transportation
46	45	Transportation by Air

INDUSTRIES

(Cont'd.)

IND SEQ	SIC CODE	INDUSTRY NAME
47	46	Pipe Line Transportation
48	47	Transportation Services
49	48	Communication
50	49	Public Utilities
51		Whilesale and Retail Trade
52	50	Wholesale Trade
53		Retail Trade
54	52	Build. Mat., Hardware, Etc.
55	53	General Merchandise
56	54	Food Stores
57	55	Auto Dealers, Gas Ser. Sta.
58	56	Apparel + Accessory Stores
59	57	Furniture, Home Furnishings
60	58	Eating and Drinking Places
61	59	Miscellaneous Retail Stores
62		Finance, Insurance + Real Estate
63	60	Banking
64	61	Other Credit Agencies
65	62	Security + Commodity Brokers
66	63	Insurance Carriers
67	64	Insr. Agents, Brokers + Serv.
68	65	Real Estate
69	66	Fire + Law Offices
70	67	Holding + Investment Comp.
71		Services
72	70	Hotels - Lodging Places
73	72	Personal Services
74	73	Misc. Business Services
75	75	Auto Repair and Services
76	76	Misc. Repair Services
77	78	Motion Pictures
78	79	Amusement + Recreation
79	80	Medical and Health Services
80	81	Legal Services
81	82	Educational Services
82	84	Museums, Art Gall., Gardens
83	86	Nonprofit Organizations
84	88	Private Households
85	89	Misc. Services
86		Government
87	91	Federal Government
88	92	State and Local Government

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